CLAIMS

1. A lithographic projection apparatus comprising:

a radiation system to provide a projection beam of radiation;

a support structure to support patterning structure, the patterning structure serves to pattern the projection beam according to a desired pattern;

a substrate table to hold a substrate;

a positioning system to position at least one of said support structure and said substrate table, said positioning system comprising a planar motor having a stator and a translator, one of said stator and said translator comprising a periodic magnet structure and the other of said stator and said translator comprising a plurality of energizable coils, said coils when energized in turn with an oscillating signal causing vibrations of said translator, said vibrations having an amplitude less than the period of said periodic magnet structure;

a projection system to project the patterned beam onto a target portion of said substrate; and

a vibration measurer to measure said vibrations of said translator and to determine the phase relationship between said translator and said stator on the basis of said measured vibrations.

2. Apparatus according to claim 1 wherein said vibration measurer measures the amplitude and direction of said vibrations.

3. Apparatus according to claim 1 wherein said vibration measurer measures the phase of said vibrations relative to said oscillating signal.

4. Apparatus according to claim 1 wherein at least some of said plurality of coils which are energized with said oscillating signal are differently oriented.

5. Apparatus according to claim 1 wherein said periodic magnet structure is comprised in said stator and said coils are comprised in said translator.

6. Apparatus according to claim 1 wherein said positioning system comprises a coarse positioning module and a fine positioning module, said planar motor being comprised in said coarse positioning module.

7. Apparatus according to claim 1 wherein said positioning system is for positioning said substrate table.

8. Apparatus according to claim 1 wherein the support structure comprises a mask table to hold a mask.

9. Apparatus according to claim 1 wherein the radiation system includes a radiation source.

10. A positioning system to position an object, said positioning system comprising:

a planar motor having a stator and a translator, one of said stator and said translator comprising a periodic magnet structure and the other of said stator and said translator comprising

a plurality of energizable coils, said coils energized in turn with an oscillating signal sufficient to cause vibrations of said translator, said vibrations having an amplitude less than the period of said periodic magnet structure; and

a vibration measurer to measure said vibrations of said translator and determine the phase relationship between said translator and said stator on the basis of said measured vibrations.

11. A device manufacturing method using a lithographic projection apparatus, the lithographic apparatus including a positioning system to position at least one of a support structure to support patterning structure and a substrate table, said positioning system comprising a planar motor having a stator and a translator, one of said stator and said translator comprising a periodic magnet structure and the other of said stator and said translator comprising a plurality of energizable coils, the method comprising:

providing a substrate that is at least partially covered by a layer of radiation-sensitive material;

providing a projection beam of radiation using a radiation system;

using patterning structure to endow the projection beam with a pattern in its cross-section;

projecting the patterned beam of radiation onto a target portion of the layer of radiation-sensitive material;

energizing a plurality of said coils in turn with an oscillating signal sufficient to cause vibrations of said translator having an amplitude less than the period of said periodic magnet structure;

measuring said vibrations of said translator; and

determining the phase relationship between said translator and said stator on the basis of said measured vibrations.

12. A device manufactured according to the method of claim 11.

13. A computer program to determine the phase relationship of a stator and a translator in a lithographic projection apparatus, the lithographic projection apparatus including a positioning system to position at least one of a substrate table and a support structure to support patterning structure, said positioning system comprising a planar motor having a stator and a translator, one of said stator and said translator comprising a periodic magnet structure and the other of said stator and said translator comprising a plurality of energizable coils, the computer program comprising program code to, when executed on a computer, perform the method of:

energizing a plurality of said coils in turn with an oscillating signal sufficient to cause vibrations of said translator, said vibrations having an amplitude less than the period of said periodic magnet structure;

measuring said vibrations of said translator; and

determining the phase relationship between said translator and said stator on the basis of said measured vibrations.